REMARKS

Applicants have amended their claims in order to define further aspects of the present invention. Specifically, the previously considered claims have not been amended; but Applicants are adding new claims 38-43 to the application. Of these newly added claims, claims 38 and 39, dependent respectively on claims 10 and 25, recite that the polyimide precursor is produced using the oxydiphthalic acid. Claims 40 and 41, dependent respectively on claims 10 and 25, recite that the photoinitiator is selected from a specified group, as set forth in the paragraph bridging pages 12 and 13 of Applicants' specification (deleting the photoinitiator set forth on page 13, lines 13 and 14, of Applicants' specification). Claims 42 and 43, dependent respectively on claims 10 and 25, recite amount of oxydiphthalic acid or acid anhydride thereof included, based on total amount of acid component of the polyimide precursor, consistent with the description on page 7, lines 8-10, of Applicants' specification.

Applicants respectfully submit that all of the claims presented for consideration by the Examiner patentably distinguish over the teachings of the prior art applied by the Examiner in rejecting claims in the Office Action mailed February 9, 2006, that is, the teachings of U.S. Patent No. 4,548,891 to Riediker, et al., under the provisions of 35 USC 103.

It is respectfully submitted that this reference as applied by the Examiner would have neither taught nor would have suggested such a photosensitive resin composition as in the present claims, including the polyimide precursor produced using an oxydiphthalic acid or acid anhydride thereof and at least one diamine as reactants for forming the polyimide precursor, the at least one diamine consisting of specified diamines listed in each of claims 10 and 25, the composition being adapted

to be exposed and developed using an i-line stepper which uses monochromatic light, the polyimide precursor being such that a 20 μm thick film thereof has a transmittance, at 365 nm, of at least 40%. See claim 10; note also claim 25.

As discussed further infra, it is respectfully submitted that the applied reference discloses a vast number of prepolymers, and would not have led one of ordinary skill in the art to the specific polyimide precursor as in the present claims, produced using an oxydiphthalic acid or acid anhydride thereof and the at least one diamine (selected from the specific group thereof) as reactants for forming the polyimide precursor, nor would have disclosed nor would have suggested properties of the polyimide precursor and of the photosensitive resin composition as in, e.g., claims 10 and 25.

Moreover, it is respectfully submitted that the applied reference would have neither taught nor would have suggested the other features of the present invention as in the remaining dependent claims which have been rejected in the Office Action mailed February 9, 2006, having features as discussed previously in connection with claims 10 and 25, and further including (but not limited to) wherein the at least one diamine used in producing the polyimide precursor consists of at least one diamine selected from the specified diaminodiphenyl ethers as in claim 17; and/or wherein the at least one diamine used in producing the polyimide precursor consists of at least one diamine selected from the group as set forth in claim 19, more particularly as set forth in claim 20; and/or wherein the polyimide precursor is produced using the oxydiphthalic acid (see claims 38 and 39); and/or wherein the polyimide precursor is a condensation product of the oxydiphthalic acid or acid anhydride thereof and the at least one diamine (see claim 24); and/or wherein the at least one diamine used in producing the polyimide precursor consists of a diaminodiphenyl

ether (see claims 12 and 13); and/or wherein the at least one diamine includes a diaminopolysiloxane as in claim 21 (see also claim 3), more particularly as in claim 22; and/or wherein the photoinitiator is selected from the group as set forth in claims 40 and 41; and/or wherein the oxydiphthalic acid or acid anhydride thereof is included in total in an amount of 20-100 mole % based on total amount of acid component of the polyimide precursor (see claims 42 and 43); and/or wherein the transmittance of the composition is in a range of a 40%-68% (see claim 4); and/or wherein the polyimide precursor is formed in an organic solvent (see claims 30 and 31), or the composition includes an organic solvent (see claims 26-29 and 34-37).

Furthermore, as will be discussed further infra, it is respectfully submitted that even assuming, arguendo, that the teachings of the applied reference would have established a prima facie case of obviousness, the evidence in the specification of the above-identified application (that is, the Examples and Comparative Examples starting from page 17 of Applicants' specification) establishes unexpectedly better results achieved according to the present invention, thereby rebutting any prima facie case of obviousness established by the teachings of the applied references. In this regard, it is respectfully submitted that the experimental data in Applicants' specification must be considered in any determination of obviousness in connection with the above-identified application. See In re DeBlauwe, 222 USPQ 191 (CAFC 1984).

The present invention is directed to a photosensitive resin composition, adapted for use with an i-line stepper.

Development of heat-resistant photosensitive materials, which enables the required portion of the resist material to remain, e.g., as a pattern on a semiconductor integrated circuit device after the pattern is formed by exposure to

light and development, has been desired. Previously known materials have utilized a g-line stepper, which employs a visible light of a wavelength of 435 nm.

However, as further reduction of processing rule in the production of semiconductor devices has occurred, it is required to shorten the wavelength of the stepper used for carrying out finer processing. Thus, an i-line stepper having a wavelength of 365 nm has increasingly been used instead of the g-line stepper having a wavelength of 435 nm.

A base polymer of, e.g., a conventional photosensitive polyimide designed for a contact/proximity exposing machine, or a g-line stepper, has substantially no transmittance particularly for the i-line having a wavelength of 365 nm. Moreover, a relatively thick polyimide film has been required for surface protection of a lead-on-chip device, and when such a thicker film is used, the low light transmittance for light of the i-line stepper causes more serious problems.

Against this background, Applicants provide a photosensitive resin composition overcoming problems of previously known photosensitive resin compositions, providing a composition which can be used with excellent image-forming ability with an i-line stepper, and which also has excellent film-forming, heat-resistance and adhesive properties. Applicants have found that with a photosensitive resin composition including, in addition to an addition-polymerizable compound and a photoinitiator, a polyimide precursor formed using an oxydiphthalic acid or acid anhydride thereof and at least one diamine consisting of at least one diamine selected from the group recited in claims 10 and 25, more particularly consisting of at least one diamine as recited in various of the other present claims, the polyimide precursor being such that a 20 μm thick film thereof has a transmittance, at 365 nm, of at least 40%, objectives according to the present

invention are achieved; and, in particular, the composition can be exposed and developed by an i-line stepper using monochromatic light. Moreover, this photosensitive resin composition, upon development, has excellent properties including heat-resistance properties, when used, for example, in manufacturing semiconductor devices.

It is emphasized that the compositions in claims 10 and 25, and claims dependent thereon, are characterized in being adapted to be exposed and developed using an i-line stepper which uses monochromatic light; and that a 20 μm thick film of the polyimide precursor thereof has a transmittance at 365 nm (that is, the i-line) of at least 40%. It is respectfully submitted that such properties would have neither been disclosed nor would have been suggested by the teachings of the applied reference.

Riediker, et al. discloses a photopolymerizable composition including polymer precursors containing photopolymerizable groups, a metallocene as photoinitiator, and optionally acrylates, methacrylates, allyl ethers or allyl esters of polyols. This patent discloses that the compositions have a high light sensitivity at wavelengths above 400 nm. See column 2, lines 9-13. As for the most general description of the photopolymerizable composition, note column 2, line 20 through column 3, line 30. See also column 3, lines 44-53, defining amounts of the various components, including photoinitiator (b), in the composition. Note especially the prepolymer (a) which contains identical or different recurring structural units of the formula I, described most generally at column 2, lines 24-34, of Riediker, et al. This patent goes on to disclose examples of suitable compounds H, H' and H'' for the preparation of the prepolymers (a), in column 11, line 41 through column 12, line 3; and discloses examples of compounds K for the preparation of the prepolymers (a),

in column 12, lines 4-41. This patent goes on to disclose that particularly preferred compositions are those in which the prepolymer (a) consists of recurring structural units of the formula Ic as shown in column 12, wherein R^4 thereof is the radical of pyromellitic dianhydride, of a benzophenonetetracarboxylic dianhydride or is a mixture of such radicals (see column 12, lines 42-66); and also compositions in which the prepolymer (a) consists of recurring structural units of the formula Id. This patent goes on to disclose at column 19, lines 63-67, that the light-sensitivity of the materials described in the patent extends from the UV range (200 nm) to about 600 nm and thus encompasses a very broad range; and, accordingly, a large number of the most different types of light sources may be used. This patent goes on to describe in column 20, lines 5-7, that particularly suitable lamps are those having a comparatively high radiation intensity in the spectral range from 400-480 nm. Examples 1 and 2, as set forth in column 21, disclose exposure being made with a metal halide lamp (see Example 1) or with a mercury high-pressure lamp (see Example 2).

Initially, it is noted that the lamps utilized for development in Examples 1 and 2 of Riediker, et al. provide polychromatic light, which is light with a variety of wavelengths, exposure being carried out using such light. It is respectfully submitted that this reference does not disclose, nor would have suggested, such a photosensitive resin composition as in the present claims, which is adapted to be exposed and developed using an i-line stepper which uses monochromatic light.

Noting contentions made by the Examiner in the paragraph bridging pages 3 and 4 of the Office Action mailed February 9, 2006, it is noted that, among many prepolymers (a), examples of suitable compounds H, H' and H" for the preparation of the prepolymers (a) include various tetracarboxylic dianhydrides, including, inter alia,

pyromellitic dianhydride and 3,3'- and 4,4'-oxydiphthalic anhydride. It is respectfully submitted, however, that the teachings of Riediker, et al. as a whole would not have directed one of ordinary skill in the art to the specific polyimide precursors as in the present claims, including properties thereof as in the present claims and advantages achieved thereby.

In particular, note that Riediker, et al. discloses use of pyromellitic dianhydride, and the polyphthalimide precursor used in the examples in Riediker, et al. employs pyromellitic acid as a starting material. Note that, according to Applicants' disclosure, polyimide precursors formed utilizing pyromellitic dianhydride produce unsatisfactory results. This is clear from in the transmittance of the polyimide precursor of Synthetic example 7 on page 20 of Applicants' specification, the transmittance being shown in Table 1 on page 21 of Applicants' specification, and from the unsatisfactory results as seen in the results for Comparative Example 1 in Table 3 on page 26 of Applicants' specification. It is respectfully submitted that the evidence in Applicants' specification, taken as a whole, and including especially Comparative Example 1 as compared with Examples 1-6 utilizing oxydiphthalic acid or acid anhydride thereof, establishes unexpectedly better results achieved according to the present invention, as compared to the closest prior art (e.g., the examples of Riediker, et al.), rebutting any possible prima facie case of obviousness established by the teachings of Riediker, et al.

On page 3 of the Office Action mailed February 9, 2006, the Examiner has directed Applicants' attention to column 11, lines 65 and 66, of Riediker, et al., "for the components used to make the polyamic acid wherein an oxydiphthalic acid anhydride is used". The paragraph bridging columns 11 and 12 of Riediker, et al. discloses many different "suitable compounds" H, H' and H'' for the preparation of

the prepolymers (a), including specific oxydiphthalic anhydrides and also pyromellitic dianhydrides, among other compounds. It is respectfully submitted that taking the teachings of Riediker, et al. as a whole, as required by 35 USC 103, such teachings, including the disclosure in column 11, lines 65 and 66, do not disclose, nor would have suggested, the photosensitive resin composition of the present claims including the recited property thereof, which composition includes the polyimide precursor as in the present claims having the recited property thereof, and unexpectedly better results achieved by this composition.

The first full paragraph in column 12 of Riediker, et al. discloses various compounds K for the preparation of the prepolymers (a). Taking the teachings of Riediker, et al. as a whole, including the portions thereof at columns 11 and 12 and referred to by the Examiner, it is respectfully submitted that the many compounds disclosed would not have directed one of ordinary skill in the art to use of the polyimide precursor as in the present claims, including properties thereof, or to the photosensitive resin composition according to the present invention and properties thereof, or advantages achieved by the present invention.

The Examiner has acknowledged that Riediker, et al. lacks a working example using an oxydiphthalic acid anhydride with a diaminodiphenyl ether as recited. Note the first full paragraph on page 4 of the Office Action mailed February 9, 2006. It must be added that Riediker, et al. includes working examples using pyromellitic acid, which Applicants' disclosure shows provides unsatisfactory results in a photosensitive resin composition corresponding to that of the present claims. Taking the evidence of record as a whole, including unexpectedly better results achieved according to the present invention, utilizing the specific components forming the polyimide precursor, and noting unsatisfactory results achieved in forming a

polyimide precursor utilizing pyromellitic acid as in examples in Riediker, et al., it is respectfully submitted that Applicants have established unexpectedly better results achieved according to the present invention, establishing patentability of the presently claimed subject matter even assuming, arguendo, that Riediker, et al. establishes a prima facie case of obviousness.

It is again emphasized that the claims rejected in the Office Action mailed February 9, 2006, recite, in addition to components of the photosensitive resin composition, a property of the polyimide precursor (that is, a 20 μm thick film thereof has a transmittance, at 365 nm, of at least 40%), together with a characteristic of the photosensitive resin composition (that is, such composition being adapted to be exposed and developed using an i-line stepper which uses monochromatic light). It is respectfully submitted that Riediker, et al. would have neither taught nor would have suggested such composition, including the polyimide precursor having the recited property and wherein the composition has the recited characteristic.

The contention by the Examiner that it would have been obvious "to substitute an oxydiphthalic acid anhydride in for the pyromellitic anhydride precursor as motivated and taught by RIEDIKER et al and reasonably expect the same or similar result as disclosed in RIEDIKER et al such as excellent sensitivity, an excellent resolution and heat resistance of the patterned images formed", is noted. It is respectfully submitted that, as can be seen in the evidence in Applicants' specification, a "same or similar result" is not achieved in using a pyromellitic anhydride precursor as in Riediker, et al. That is, unexpectedly better results are achieved according to the present invention utilizing the oxydiphthalic acid or anhydride thereof in forming the polyimide precursor. Clearly, Applicants show in, for example, Comparative Example 1, that a polyimide precursor using pyromellitic

acid as an acid component in forming the polyimide did not achieve a composition providing resolution or a pattern as achieved by the present invention.

Moreover, it is noted that Riediker, et al. requires a specific photoinitiator which is a metallocene of the formula II as set forth in column 2 of the patent; and, moreover, in column 11 discloses use of specific oxydiphthalic anhydrides. It is respectfully submitted that the disclosure of this patent would have neither taught nor would have suggested, and in fact would have taught away from, compositions as in, for example, claims 38-41.

The Examiner is thanked for the indicated allowance of claims 23 and 28, as set forth in Item 4 on page 4 of the Office Action mailed February 9, 2006.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the above-identified application are respectfully requested.

Applicants request any shortage in fees due in connection with the filing of this paper be charged to the Deposit Account of Antonelli, Terry, Stout & Kraus, LLP, Deposit Account No. 01-2135 (case 511.33114CC6) and credit any excess fees to such deposit account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By _____
William I. Solomon
Registration No. 28,565

WIS/ksh
1300 N. Seventeenth Street
Suite 1800
Arlington, Virginia 22209
Tel: 703-312-6600
Fax: 703-312-6666